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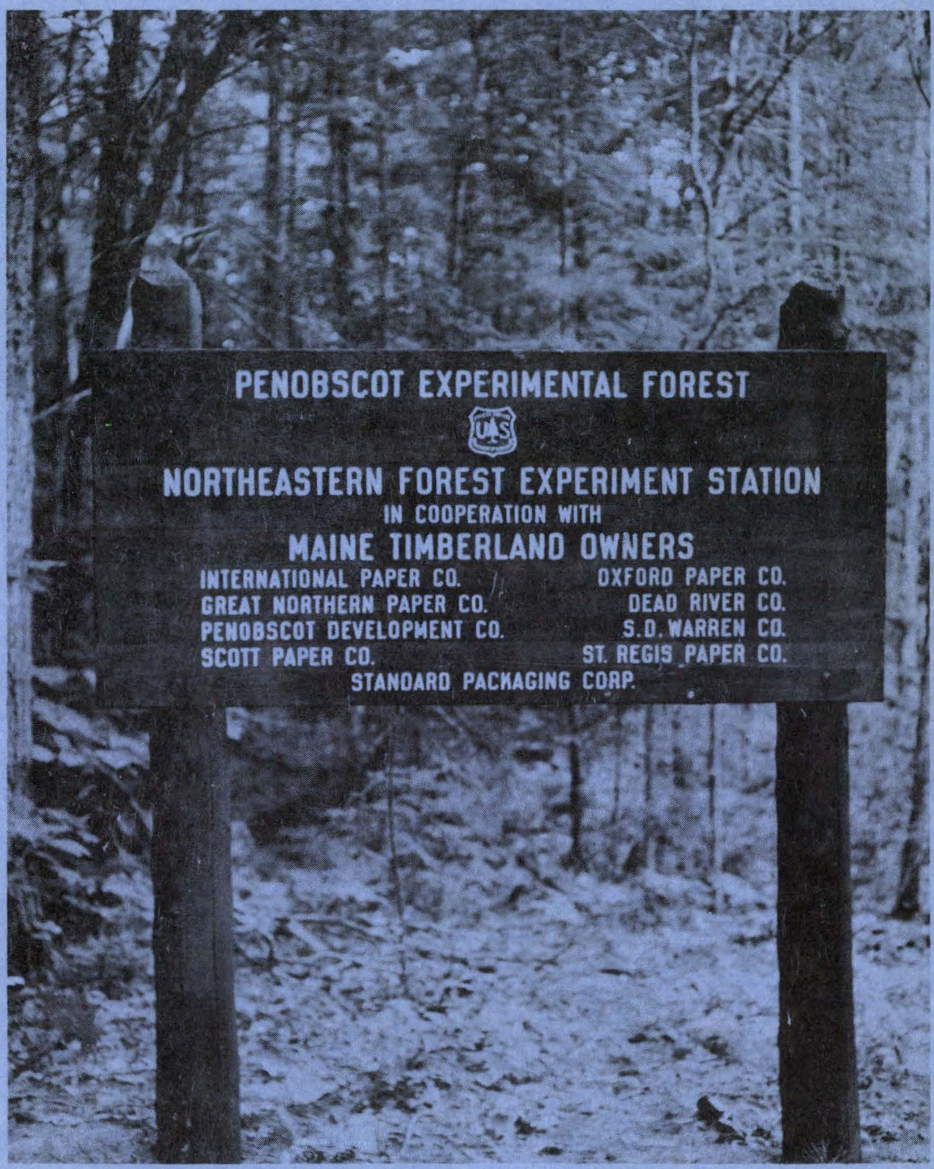
PENOBSCOT
Experimental Forest



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Univ. of New Brunswick Field Trip
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Univ. of Maine Management Guide
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THE FORESTS OF MAINE

Maine is truly a forest state with more than 87 percent of the total land area in forests, and less than one million people. No other state has as large a proportion of its land in forests and only seven states have a greater forest acreage--none of them in the Northeast.

Forests are Maine's greatest natural resource. They supply the raw material for the wood-using plants that comprise the state's largest industry. The forests and the lakes and streams they support also provide the base for recreation, the state's second largest industry. The forests are also the source of water for domestic and industrial use.

The Maine woodlands have supported a large proportion of the state's economy for better than 350 years, yet they are far from being exhausted or seriously depleted. The recently completed forest survey conducted by the Northeastern Station shows that Maine has about one-third more timber volume than previously reported. According to the survey, the state's net volume in 1958 amounted to 206 million cords on the 17,169,000 acres of commercial forest land. Only five states--all in the West--Oregon, Washington, Idaho, California, and Alaska--have a greater volume of standing timber.

The cut of forest products has increased substantially during the last decade, yet in 1958 considerably less was cut than was grown. Total forest drain for 1958 amounted to 3.1 million cords whereas total net growth was nearly 7.2 million cords--nearly 2½ times the drain. About 53 percent of the cut was in pulpwood material; 37 percent in sawlogs; the remainder for veneer, fuelwood, and other products.

Net growth was estimated at 0.42 rough cords per acre in 1958, after deducting a mortality loss of 0.20 cord per acre. An average of 0.18 cords was cut per acre. The difference, 0.24 cords, was added to the timber inventory. Most of this addition was in the pole-size classes as the cut of sawtimber-size material amounted to 83 percent of the growth whereas the cut of poletimber amounted to only 20 percent of the growth in trees of this class. It is worth noting that in 1958 in all size classes a larger volume of trees died than was harvested.

Not all species are utilized to the same extent. The 1958 cut of sugar maple, beech, and red oak was 1/4 to 1/3 greater than growth of these species during that year; the cut of paper birch was equal to 1/3 of the growth; yellow birch 2/3 of the growth; and red maple, aspen, ash, and other miscellaneous hardwoods only 7 percent of their combined growth in 1958. The cut of spruce and fir amounted to 35 percent of the growth; that of other softwoods was 47 percent; but the cut of white and red pine exceeded their growth by 20 percent.

THE PENOBSCOT EXPERIMENTAL FOREST

The Penobscot Experimental Forest was established in 1950 through the combined efforts of nine large, land-owning companies. Recognizing the need for more forest research, these companies purchased a tract of 3,800 acres and turned it over to the Northeastern Forest Experiment Station under a 99-year lease for research in forest management. Later, another 200 acres were added.

This was a unique move in American forestry. It was the first time that a group of private wood-using industries had purchased a tract of timber for lease to the Federal Government for research purposes.

The nine companies that took part in this unusual transaction were the Dead River Company, the Eastern Corporation (now Standard Packaging Corporation), the Great Northern Paper Company, the Hollingsworth and Whitney Company (now Scott Paper Company), the International Paper Company, the Oxford Paper Company, the Penobscot Development Company, the S. D. Warren Paper Company, and the St. Regis Paper Company.

The owners are represented by a 3-man operating committee in working with the Northeastern Forest Experiment Station for the orderly management and use of the Experimental Forest. Each company is also represented on the Forestry Research Advisory Committee which meets annually to advise the Station in the Orono Project's research program, both on and off the forest.

The Experimental Forest is administered by the Northeastern Forest Experiment Station through its Orono Project. The Station plans and conducts all research activities. It also is responsible for all logging operations; for the maintenance of roads, boundaries, and improvements; and for other administrative matters. The Station makes no payment to the owners for use of the land other than payments for stumpage cut in the course of research operations. These receipts are turned over to the Operating Committee for payment of taxes on the property.

The Forest is mostly of a softwood type. However, many minor variations in composition occur. These may be grouped into two principal subtypes. One is a northern white-cedar-balsam fir mixture containing small amounts of white spruce and red maple. This subtype occurs on very wet, shallow soils. The other subtype is spruce-fir-hemlock, which predominates on the Forest. This subtype occurs on the better drained flats and slopes. The common associated species in this subtype are paper birch and the ever-present red maple, along with white pine on the relatively drier sites and cedar on the wetter sites.

THE RESEARCH PROGRAM ON THE FOREST

The research program on the Experimental Forest is designed to serve the 15,200,000-acre spruce-fir region of Maine and northern New Hampshire. The work has been confined largely to applied forest-management research in the spruce-fir and closely associated types.

When the experimental forest was established in 1950 the most important and urgent problem was for knowledge of how to cut operable spruce-fir stands to obtain the greatest net return over a long period of time. The major research effort on the Forest was accordingly devoted to a comparison of the different methods of managing mature stands.

As the years passed, woodland owners not only became progressively more interested in improvement methods of operating merchantable stands but also began planning for the more intensive management and, where necessary, the improvement of stands below merchantable size. Studies in regeneration, thinning, pruning, and other cultural measures were subsequently installed on the forest to at least partially meet this need.

Work was also begun on the regeneration of paper birch in 1958 when funds became available for a limited amount of work on hardwoods associated with the spruce-fir type. The Maine Hardwood Association is cooperating on this project.

Other studies on the Experimental Forest are carried on by the Orono Project to provide somewhat more basic information for application to management problems. Some examples are studies of the causes and volume of fir mortality, the occurrence of balsam woolly aphid attack under different types of management, the control of the aphid by predators, and the consumption of spruce and fir seed by small mammals.

The experimental forest is also used by others on a cooperative basis: the Maine Dept. of Inland Fisheries and Game is conducting several studies on the Forest, including a large-scale study of the quantity and quality of food and cover provided by different cutting methods; Forest pathologists from the Station's West Haven Laboratory are following the rate of spread of different decay-causing fungi in the principal softwood and hardwood species; the ARS Laboratory at Beltsville, Maryland, is investigating ways of assessing insect damage by means of colored aerial photos; and the Station's geneticists have installed one replication of their regional white pine provenance study on the forest.

MANAGEMENT INTENSITY DEMONSTRATION PLOTS

In 1950 a demonstration of four management intensities as they might apply to merchantable stands in the spruce-fir region was established on the Penobscot Experimental Forest. The primary objective is to provide an on-the-ground comparison of varying intensities of management.

These management intensities include: (1) commercial clearcutting which removes all the merchantable trees, leaving scattered unmerchantable trees of poor vigor, low quality, and undesirable species: (2) diameter-limit cutting, removing all merchantable trees of desirable species above specified diameter limits and retaining all trees of certain undesirable species along with desirable trees below the minimum diameter: (3) selection-management cutting based on the marking and removal of mature trees, and defective, slow-growing, and lower-value trees in all size classes plus a limited amount of stand-improvement work every fifteen years: and (4) intensive-selection management in which the stand is also progressively upgraded through marking and stand-improvement measures but on a more intensive basis and on a 5-year cutting cycle.

Commercial Clear-Cut Plot

Date established: February 1950.

Area: 10 acres.

Soils: Four soil types are represented on this plot. Poorly and very poorly drained, stony silt loam and silt loam make up 60 per cent, while well-drained stony loams cover the remaining 40 per cent of the area.

Management: Commercial clear cut was made of all trees considered merchantable by the stump cutting system of operating. No stand improvement measures have been made. The area is to be cut again when operable -- perhaps in 45 to 60 years.

Product objective: Pulpwood only.

Description: In 1950 before cutting, the plot supported a stand of 2,092 cubic feet (24.61 rough cords) per acre in trees 4.6 inches d.b.h. and larger. There were 1,516 cubic feet (17.83 cords) of spruce and fir; 84 cubic feet (0.99 cords) of hemlock; 230 cubic feet (2.71 cords) of beech-birch-maple; and 262 cubic feet (3.08 cords) of other species -- cedar, pine, larch, and ash.

Logging: The stand was not marked. The loggers were allowed to cut and peel all trees they considered merchantable for pulpwood. Cutting was done in the summer of 1950 by a crew of 4 to 6 men using axes, one-man chain saws, and bark spuds. Trees were bucked with power saws and piled along sled roads for winter hauling. The equivalent of 14,53 cords (mill scale) per acre on a rough wood basis were removed. No pine, cedar, larch, or ash trees were cut. About 1 acre of mostly unmerchantable-size trees was not cut.

Discussion: A cutting of this type leaves the land with a limited means for natural reproduction of desirable species. It leaves scattered unmerchantable seed trees of low quality. It also robs the stand of minimum-size merchantable trees in stages of rapid growth. It is characterized by forest deterioration; by regeneration of short-lived species, brush, and weeds; with consequent reduction in both quality and quantity of future forest growth.

Average growth and mortality in cubic feet on the commercial clear-cut plot[1/]

Species group	Nov. 1951	Annual volume in cubic feet per acre					Oct. 1964
		Ingrowth[2/]	Accretion[3/]	Gross growth	Mortality[4/]	Net growth[5/]	
Spruce & fir	253.0	5.9	14.3	20.2	8.2	12.0	409.0
Hemlock	45.6	1.4	5.4	6.8	.1	6.7	133.2
All Sftwds	546.1	8.8	30.0	38.8	10.2	28.6	917.3
Be-Bir-Ma	203.4	3.0	9.5	12.5	2.7	9.8	330.4
All Hdwds	214.7	3.2	9.8	13.0	3.0	10.0	344.7
All Species	760.8	12.0	39.8	51.8	13.2	38.6	1,262.0

Average growth and mortality in rough cords on the commercial clear-cut plot[1/, 6/]

Species group	Nov. 1951	Annual volume in rough cords per acre					Oct. 1964
		Ingrowth[2/]	Accretion[3/]	Gross growth	Mortality[4/]	Net growth[5/]	
Spruce & fir	2.98	0.07	0.17	0.24	0.10	0.14	4.81
Hemlock	.54	.02	..06	.08	.00	.08	1.57
All Sftwds	6.42	.10	.35	.46	.12	.34	10.79
Be-Bir-Ma	2.39	.04	.11	.15	.03	.12	3.89
All Hdwds	2.53	.04	.12	.15	.03	.12	4.06
All Species	8.95	.14	.47	.61	.15	.46	14.85

1/ Volume or basal area growth and mortality in trees 4.6 inches d.b.h. and larger.
2/ Volume or basal area in trees growing into the merchantable class.
3/ Growth on live trees in the merchantable class at time of first measurement.
4/ Volume or basal area lost through death of trees.
5/ Includes an undetermined amount of hidden defect and growth on cull trees.
6/ Rough cord containing 85 cubic feet solid wood content.

Average growth and mortality in basal area on commercial clear-cut plot[1/]

Species group	Nov. 1951 over 0.6 inches	Annual basal area in square feet per acre					Oct. 1964 over 0.6 inches
		Ingrowth[2/]	Accretion[3/]	Gross Growth	Mortality[4/]	Net Growth	
Spruce-fir	21.898	0.446	0.623	1.069	0.482	0.587	27.733
Hemlock	3.439	.145	.280	.425	.005	.420	9.065
All softwoods	41.168	.735	1.323	2.058	.607	1.451	58.558
Beech-Birch-Maple	14.223	.281	.472	.753	.145	.608	21.828
All hardwoods	14.999	.317	.438	.755	.168	.587	23.080
All Species	56.167	1.052	1.761	2.813	.775	2.038	81.638

1/ Basal area growth and mortality in trees 4.6 inches d.b.h. and larger.

2/ Basal area in trees growing into the merchantable class.

3/ Growth on live trees in the merchantable class at time of first measurement.

4/ Basal area lost through death of trees.

From 16 to 21 per cent of the area is cleared for roads, and dense accumulations of slash buildup between the roads smothering out seedlings and preventing new seedlings from becoming established for periods up to 15 years.

Growth: Bases on 100-per cent inventories made in 1951 and 1964, the residual stand of 761 cubic feet (8.95 rough cords) per acre has grown at the rate of 39 cubic feet (0.46 cord, net) per acre annually since the plot was cut.

Diameter-Limit Plot

Date established: February 1950.

Area: 10 acres.

Soils: Two soil types are represented on this plot. One is a well-drained stony loam which covers 56 percent of the area. The remaining 44 percent is a poorly drained stony silt loam.

Management: 1. Cut to a diameter limit as follows:

a. Cut all merchantable fir and red maple.

b. Cut spruce and hemlock merchantable trees above 9.5 inches d.b.h.

c. Cut paper birch and beech merchantable trees above 7.5 inches d.b.h.

2. Skid trees to bucking yards along truck road -- no stump cutting.

3. General instructions to cutters at beginning of work to be careful of the smaller trees.

4. No stand-improvement measures are included.

5. Cut again when operable under the same cutting rules.

Product objective: Pulpwood only.

Description: In 1950 before cutting, the plot supported a stand of 1,970 cubic feet (23.18 rough cords) per acre in trees 4.6 inches d.b.h. and larger. There were 800 cubic feet (9.42 cords) of spruce and fir; 618 cubic feet (7.27 cords) of hemlock; 380 cubic feet (4.47 cords) of beech-birch-maple; and 172 cubic feet (2.02 cords) of other species -- cedar, pine, larch, and ash.

Average growth and mortality in cubic feet on the diameter-limit plot[1/]

Species group	Nov. 1951	Annual volume in cubic feet per acre					Oct. 1964
		Ingrowth[2/]	Accretion[3/]	Gross growth	Mortality[4/]	Net growth[5/]	
Spruce & fir	447.6	4.8	21.1	25.9	4.8	21.1	721.4
Hemlock	407.2	4.4	22.1	26.5	1.5	25.0	732.0
All Sftwds	1,003.3	10.1	48.1	58.2	8.0	50.2	1,656.1
Be-Bir-Ma	280.0	3.7	12.9	16.6	5.9	10.7	419.2
All Hdwds	287.8	3.9	13.2	17.1	5.9	11.2	433.9
All Species	1,291.1	14.0	61.3	75.3	13.9	61.4	2,090.0

Average growth and mortality in rough cords on the diameter-limit plot[1/, 6/]

Species group	Nov. 1951	Annual volume in rough cords per acre					Oct. 1964
		Ingrowth[2/]	Accretion[3/]	Gross growth	Mortality[4/]	Net growth[5/]	
Spruce & fir	5.26	0.05	0.25	0.30	0.05	0.25	8.49
Hemlock	4.79	.05	.26	.31	.02	.29	8.61
All Sftwds	11.80	.12	.56	.68	.09	.59	19.48
Be-Bir-Ma	3.29	.04	.16	.20	.07	.13	4.93
All Hdwds	3.38	.04	.16	.20	.07	.13	5.10
All Species	15.18	.16	.72	.88	.16	.72	24.58

1/ Volume or basal area growth and mortality in trees 4.6 inches d.b.h. and larger.
2/ Volume or basal area in trees growing into the merchantable class.
3/ Growth on live trees in the merchantable class at time of first measurement.
4/ Volume or basal area lost through death of trees.
5/ Includes an undetermined amount of hidden defect and growth on cull trees.
6/ Rough cord containing 85 cubic feet solid wood content.

Average growth and mortality in basal area on the diameter-limit plot[1]

Species group	Nov. 1951 over 0.6 inches	Annual basal area in square feet per acre					Oct. 1964 over 0.6 inches
		Ingrowth[2]	Accretion[3]	Gross Growth	Mortality[4]	Net Growth	
Spruce-fir	32.697	0.358	0.806	1.164	0.277	0.887	41.200
Hemlock	32.032	.427	1.148	1.575	.089	1.486	56.666
All softwoods	74.165	.868	2.151	3.019	.468	2.551	109.884
Beech-Birch-Maple	20.271	.308	.739	1.047	.344	.703	27.937
All Hardwoods	21.212	.350	.738	1.088	.350	.738	28.898
All Species	95.377	1.218	2.889	4.107	.818	3.289	138.782

1/ Basal area growth and mortality in trees 4.6 inches d.b.h. and larger.

2/ Basal area in trees growing into the merchantable class.

3/ Growth on live trees in the merchantable class at time of first measurement.

4/ Basal area lost through death of trees.

Logging: The cutting was done in the summer of 1950 by a crew of 4 to 6 men using axes, one-man power saws, and bark spuds. Trees were skidded in long lengths by single horses to bucking yards along the winter haul road. The equivalent of 7.87 cords (mill scale) acre on a rough-wood basis were removed. No pine, cedar, larch, or ash trees were cut.

Discussion: A diameter-limit cutting usually results in uneven stocking. Areas occupied by stands of trees mostly below the diameter limits tend to be overstocked; areas where most of the trees are over the diameter limits will be understocked after cutting. However, minimum-size merchantable trees in stages of rapid growth are retained for another crop of pulpwood in the foreseeable future. Only about 8 percent of the area is cleared for roads and yards, and dense accumulations of slash do not usually occur.

Growth: Based on 100-percent inventories made in 1951 and 1964, the 1,291 cubic feet (15.18 rough cords) per acre retained as growing stock has grown at the rate of 61 cubic feet (0.72 cord, net) per acre annually since the plot was first cut.

Second cut: In 1965 a second cut was made, removing 1,060 cubic feet (estimated 12.46 rough cords -- mill scale was 12.69 cords) per acre. This left a growing stock of 1,030 cubic feet (12.12 cords) per acre. White pine trees above 11.5 inches d.b.h. were cut in addition to the species and diameter limits described for the 1950 cut.

Selection-Management Plot

Date established: February 1950.

Area: 10 acres

Soils: Three soil types are represented on this plot. Well-drained stony loams make up 75 percent, while poorly and very poorly drained stony silt loam and very stony soils cover the remaining 25 percent of the area.

Management: Single-tree selection on a marked tree basis under the following cutting rules:

1. Mark all trees to be cut.

2. Skid trees to bucking yards along truck roads -- no stump cutting.

3. Volume removed not to exceed:
   a. Initial cut -- no more than 1/3 of the original gross volume.
   b. Subsequent cuts -- no more than 3/4 of the periodic growth until optimum stocking is reached.

4. The cut to be made up of:
   a. All merchantable trees that will not increase in value over the next 15 years.
   b. Flexible limits for all other merchantable trees. Trees above the limits to be left only when silviculturally or economically desirable:
      (1) Fir 7.5 inches.
      (2) Pine and hemlock 11.5 inches.
      (3) Spruce 13.5 inches.
      (4) Paper birch 9.5 inches.
      (5) Others 7.5 inches.

5. Stand-improvement measures within the following limits and only at the time of each cutting:
   a. Girdle or poison cull trees to liberate pole-sized trees of desirable species.
   b. Thin softwood pole stands where needed to favor spruce, hemlock, and fir, in that order.
   c. Prune up to 30 pine and/or spruce crop trees per acre.
   d. Reinforcement planting only if less than 80 percent of the area is stocked with one or more seedlings after the second cut.

6. Cutting cycle of 15 years.

7. Logging damage to the reserved stand and to the site to be prevented by supervision of the operation.

Average growth and mortality in cubic feet on the selection-management plot[1]

Species group	Nov. 1951	Annual volume in cubic feet per acre					Oct. 1964
		Ingrowth[2]	Accretion[3]	Gross growth	Mortality[4]	Net growth[5]	
Spruce & fir	317.8	3.4	14.5	17.9	3.2	14.7	509.1
Hemlock	622.0	4.8	33.5	38.3	.7	37.6	1,111,4
All Sftwds	1,007.1	8.7	49.6	58.3	5.5	52.8	1,694.0
Be-Bir-Ma	371.3	4.5	15.3	19.8	6.8	13.0	539.8
All Hdwds	371.3	4.5	15.3	19.8	6.8	13.0	539.8
All Species	1,378.4	13.2	64.9	78.1	12.3	65.8	2,233.8

Average growth and mortality in rough cords on the selection-management plot[1],[6]

Species group	Nov. 1951	Annual volume in rough cords per acre					Oct. 1964
		Ingrowth[2]	Accretion[3]	Gross growth	Mortality[4]	Net growth[5]	
Spruce & fir	3.74	0.04	0.17	0.21	0.04	0.17	5.99
Hemlock	7.31	.06	.39	.45	.01	.44	13.07
All Sftwds	11.84	.10	.58	.68	.06	.62	19.93
Be-Bir-Ma	4.37	.05	.18	.23	.08	.15	6.35
All Hdwds	4.37	.05	.18	.23	.08	.15	6.35
All Species	16.21	.15	.76	.91	.14	.77	26.28

1/ Volume or basal area growth and mortality in trees 4.6 inches d.b.h. and larger.
2/ Volume or basal area in trees growing into the merchantable class.
3/ Growth on live trees in the merchantable class at time of first measurement.
4/ Volume or basal area lost through death of trees.
5/ Includes an undetermined amount of hidden defect and growth on cull trees.
6/ Rough cord containing 85 cubic feet solid wood content.

Average growth and mortality in basal area on the selection-management plot[1/]

Species group	Nov. 1951 over 0.6 inches	Annual basal area in square feet per acre					Oct. 1964 over 0.6 inches
		Ingrowth[2/]	Accretion[3/]	Gross Growth	Mortality[4/]	Net Growth	
Spruce-fir	27.299	0.277	0.527	0.804	0.177	0.627	33.865
Hemlock	49.488	.464	1.612	2.076	.039	2.037	71.249
All softwoods	81.906	.794	2.194	2.988	.317	2.671	110.506
Beech-Birch-Maple	29.386	.398	.814	1.212	.394	.818	38.030
All Hardwoods	29.386	.398	.814	1.212	.394	.818	38.030
All Species	111.292	1.192	3.008	4.200	.711	3.489	148.536

1/ Basal area growth and mortality in trees 4.6 inches d.b.h. and larger.

2/ Basal area in trees growing into the merchantable class.

3/ Growth on live trees in the merchantable class at time of first measurement.

4/ Basal area lost through death of trees.

Product objective: Integrated products.

Description: In 1950 before cutting, the plot supported a stand of 1,778 cubic feet (20.92 rough cords) per acre in trees 4.6 inches d.b.h. and larger. There were 339 cubic feet (3.99 cords) of spruce and fir; 809 cubic feet (9.52 cords) of hemlock; 551 cubic feet (6.49 cords) of beech-birch-maple; and 79 cubic feet (0.93 cord) of other species -- cedar, pine, larch, and ash.

Logging: The cutting was done in the summer of 1950 by a crew of 4 to 6 men using axes, one-man power saws, and bark spuds. Trees were skidded in long lengths by single horses to bucking yards along the winter haul road. The equivalent of 4.59 cords (mill scale) per acre on a rough wood basis were removed. No pine, cedar, larch, or ash trees were cut.

Discussion: An improvement cutting of this type removes the trees of poor quality, poor vigor, and of less desirable species, retaining the better trees for increased growth. The relatively short cutting cycle permits a closer control of the growing stock and permits some of the mortality to be salvaged. The dense stocking probably will result in the elimination of the shade-tolerant species such as pine and paper birch over a period of years, unless some catastrophe occurs.

Growth: Based on 100 percent inventories made in 1951 and 1964, the 1,378 cubic feet (16.21 rough cords) per acre retained as growing stock has grown at the rate of 66 cubic feet (0.77 cord, net) per acre annually since the plot was first cut.

Second cut: In 1965 a second cut was made, removing 764 cubic feet (estimated 8.98 rough cords -- mill scale was 9.12 cords) per acre. This left a growing stock of 1,447 cubic feet (17.30 cords) per acre.

Intensive Selection-Management Plot

Established: February 1950.

Area: 10 acres.

Soils: Three soil types are represented on this plot. Poorly and very poorly drained stony silt loam and very stony soils make up 75 percent while well-drained stony loams cover the remaining 25 percent of the area.

Management: Single tree selection on a marked tree basis under the following cutting rules:

1. Mark all trees to be cut.

2. Skid trees in long lengths to bucking yards along haul roads.

3. Cutting cycle of 5 years.

4. Volume removed not to exceed:
   a. Initial cut -- not more than 35 percent of the original gross volume.
   b. Subsequent cuts -- not more than 50 percent of periodic growth until optimum stocking and stand structure has been reached, then 100 percent of periodic growth.

5. In initial cut, remove all merchantable trees that will not increase in value over the next 5 years. No other sound trees to be cut except for thinning and stand-improvement work.

6. Stand-improvement measures every 5 years to include:
   a. Eliminate cull trees.
   b. Thin where needed to favor spruce, pine, or fir, in that order.
   c. Weed where needed in young stands.
   d. Maintain up to 75 pruned trees per acre.
   e. Reinforcement planting if less than 80 percent of the area is stocked with one or more seedlings or saplings after the second cut.

7. Prevent logging damage to the residual stand and to the site by close supervision of the logging crew.

Product objective: Integrated products.

Average growth and mortality in cubic feet on the intensive selection-management plot[1/]

Species group	Nov. 1951	Annual volume in cubic feet per acre					Oct. 1964	Cut in 1955 1960
		Ingrowth[2/]	Accretion[3/]	Gross Growth	Mortality[4/]	Net Growth[5/]		
Spruce-fir	660.4	3.2	23.6	26.8	5.2	21.6	824.9	115.8
Hemlock	732.7	3.1	32.4	35.5	.2	35.3	961.2	231.5
All Softwoods	1,511.9	6.4	59.9	66.3	7.2	59.1	1,908.3	361.8
Beech-Birch-Maple	243.7	3.8	6.5	10.3	3.4	6.9	198.1	135.0
All Hardwoods	247.7	4.0	6.4	10.4	3.4	7.0	202.2	136.6
All Species	1,759.6	10.4	66.3	76.7	10.6	66.1	2,110.5	498.4

1/ Volume, growth, and mortality in trees 4.6 inches and larger.

2/ Volume in trees growing into the merchantable class.

3/ Growth on live trees in the merchantable class at time of first measurement.

4/ Volume lost through death of trees.

5/ Includes an undetermined amount of hidden defect and growth on cull trees.

Average growth and mortality in rough cords on the intensive selection-management plot 1/, 6/

Species Group	Nov. 1951	Annual volume in rough cords per acre					Oct. 1964	Cut in 1955 1960
		Ingrowth 2/	Accretion 3/	Gross Growth	Mortality 4/	Net Growth 5/		
Spruce-fir	7.77	0.04	0.28	0.32	0.06	0.25	9.70	1.36
Hemlock	8.62	.03	.39	.42	.00	.42	11.31	2.73
All Softwoods	17.79	.08	.70	.78	.08	.70	22.45	4.25
Beech-Birch-Maple	2.87	.04	.08	.12	.04	.08	2.33	1.59
All Hardwoods	2.91	.04	.08	.12	.04	.08	2.38	1.61
All Species	20.70	.12	.78	.90	.12	.78	24.83	5.86

1/ Volume, growth, and mortality in trees 4.6 inches and larger.

2/ Volume in trees growing into the merchantable class.

3/ Growth on live trees in the merchantable class at time of first measurement.

4/ Volume lost through death of trees.

5/ Includes an undetermined amount of hidden defect and growth on cull trees.

6/ Rough cord containing 85 cubic feet of solid wood content.

Average growth and mortality in basal area on the intensive selection-management plot[1/]

Species group	Nov. 1951 over 0.6 inches	Annual basal area in square feet per acre					Oct. 1964 over 0.6 inches
		Ingrowth[2/]	Accretion[3/]	Gross Growth	Mortality[4/]	Net Growth	
Spruce-fir	40.430	0.235	0.867	1.102	0.281	0.821	43.500
Hemlock	53.144	.307	1.601	1.908	.040	1.868	65.576
All softwoods	102.839	.601	2.581	3.182	.417	2.765	116.866
Beech-Birch-Maple	18.676	.396	.212	.608	.219	.389	14.239
All hardwoods	19.829	.427	.195	.622	.222	.400	14.553
All Species	122.668	1.028	2.776	3.804	.639	3.165	131.419

1/ Basal area growth and mortality in trees 4.6 inches d.b.h. and larger.

2/ Basal area in trees growing into the merchantable class.

3/ Growth on live trees in the merchantable class at time of first measurement.

4/ Basal area lost through death of trees.

Description: In 1950 before cutting, the plot supported a stand of 2,055 cubic feet (24.18 rough cords) per acre in trees 4.6 inches d.b.h. and larger. There were 772 cubic feet (9.08 cords) of spruce and fir; 781 cubic feet (9.19 cords) of hemlock; 367 cubic feet (4.32 cords) of beech-birch-maple; and 135 cubic feet (1.59 cords) of other species -- cedar, pine, larch, and ash.

Logging: The logging was done in the summer of 1950 by a crew of 4 to 6 men using axes, one-man chain saws, and bark spuds. Trees were skidded in long lengths by single horses to bucking yards along the road. Bucking was done with power saws. The equivalent of 5.09 cords (mill scale) per acre on a rough wood basis were removed. No pine, cedar, larch, or ash trees were cut.

Second cut: In 1955 a second cut was made, removing 203 cubic feet (2.39 rough cords) per acre. This left a growing stock of 1,779 cubic feet (20.93 cords) per acre.

Third cut: In 1960 a third cut was made, removing 295 cubic feet (3.47 rough cords) per acre. This left a growing stock of 1,832 cubic feet (21.55 cords) per acre.

Growth: Based on 100-percent inventories made in 1951 and 1964, plus the trees cut in 1955 and 1960 the 1,760 cubic feet (20.70 rough cords) per acre retained as growing stock has grown at the rate of 66 cubic feet (0.78 cord) per acre annually since the plot was first cut.

Discussion: Improvement cuttings of this type remove trees of poor quality, poor vigor, and of less desirable species, retaining the better trees for increased growth. The very short cutting cycle permits close control of the growing stock and permits mortality to be salvaged.

Fourth cut: In 1965 a fourth cut was made, removing 249 cubic feet (estimated 2.93 rough cords -- mill scale was 2.90 cords) per acre. This left a growing stock of 1,862 cubic feet (21.90 cords) per acre.

NATURAL REGENERATION OF PAPER BIRCH

This study was established to test the relative value of four different methods of scarifying seedbeds--disking after logging, burning after logging, summer logging, winter logging--as a means of reproducing paper birch following clearcutting.

Established: 1958.

Terminated: 1963.

Size of study area: 8 plots each 0.45 acres.

Exposed mineral soil: After disking, 74 percent of the disked area was exposed mineral soil; after burning, 70 percent. Summer logging and winter logging (check treatment) exposed 6 percent and 5 percent respectively.

Seed source: In addition to the paper birch trees in the residual stand surrounding the clearcut area, 50 seed trees were left evenly distributed over the study area.

Three years of trapping seeds in the clear-cutting showed differences in amount of seedfall, time of dispersal, and viability. These annual data are as follows:

Month	1958-1959		1959-1960		1960-1961	
	Amt. seed dispersed	Viability	Amt. seed dispersed	Viability	Amt. seed dispersed	Viability
	-------Percent-----		-------Percent-------		-------Percent-------	
August	6	0	58	22	51	75
September	13	1	25	20	13	78
October	63	11	13	41	20	74
November	14	24	3	32	14	80
Dec.-May	4	34	1	18	2	79
Total	100	13	100	24	100	77
Est. No/Acre (million)	1.3		0.8		16.8	

Percent stocking: By September 1963 (after 5 growing seasons) paper birch seedlings were the stocking, or tallest, species on 36 percent of the quadrats on the disked plots and 34 percent of those on the burned plots. However, aspen exceeded birch as a stocking species in these two treatments: aspen stocked 47 percent of the disked plots, 46 percent of the burned plots.

On the other hand, softwoods and hardwood sprouts (including paper birch) were the major stocking species in both the summer and the winter logged plots. Summer logging resulted in 40 percent softwood stocking, 27 percent hardwood sprouts, and only 12 percent paper birch. Winter logging resulted in 29 percent softwood, 36 percent hardwood sprouts, and 15 percent paper birch.

Number of stems per acre: The estimated number (in thousands) by species and treatment are as follows:

Species	Disked plots	Burned plots	Summer logged plots	Winter logged plots
Paper birch	50	19	12	8
Aspen	9	2	2	1/
Gray birch	5	3	3	1
Fire cherry	2	1	2	1
Other hardwoods	1/	--	1	1
Softwoods	1	--	5	2
Hardwood sprouts	1/	1/	2	4
Total	67	25	27	17

1/ Less than 500 stems.

Average height of dominants: The average height of the dominants by species and treatment, September 1963 are as follows:

Species	Disked plots	Burned plots	Summer logged plots	Winter logged plots
Paper birch	2.5	2.8	2.6	2.9
Aspen	3.0	3.6	5.8	4.8
Gray birch	2.6	2.6	2.2	3.2
Fire cherry	2.5	3.2	2.7	2.6
Other hardwoods	3.7	---	3.3	6.0
Softwoods	3.5	3.2	4.4	4.0
Hardwood sprouts	4.5	4.9	6.6	6.8

COMPARTMENT 21

Date Established: November 1956

Area: 33 Acres

Silvicultural System: Shelterwood, 2-cut

Product Objective: Pulpwood

Objective of First Cut: To create favorable conditions for growth of advance reproduction and for establishment of new reproduction. Trees left standing should be those most likely to yield highest rate of return in increased growth and of desireable species for seeding purposes. No timber stand improvement work will be performed.

Objective of Second Cut: To completely release the advance reproduction This cut will remove all merchantable trees when it is estimated that 65 percent or more of the area contains at least 1,000 trees per acre 1 foot in height or higher. No timber stand improvement work will be performed.

Table 1. -- Volume on compartment and volume cut

Date		Cords per Acre
Nov. 1956	Original stand	22.0
Jul. 1957	Volume removed 1st cut	11.0
Sep. 1957	Residual stand	11.0
Aug. 1963	2nd remeasurement	16.0
Mar. 1967	3rd remeasurement	19.0
Oct. 1967	Volume removed final cut	17.5
Sep. 1968	Present volume	1.5

Table 2. -- Status of reproduction as of June 1965

	Size Class	Number	Percent Spruce-fir
Number	6.0" to 1.0'	7100	64
per	1.0' to 0.49" d.b.h.	2500	45
Acre	All classes	9600	59

	Size Class	Percent Stocking All Species	Spruce-fir
Percent	Under 1.0'	98	at least 96
Stocking	1.0' to 0.49" d.b.h.	at least 44	at least 24

COMPARTMENT 23

Date Established: December 1954

Area: 26 acres

Silvicultural System: Shelterwood, 3-cut

Product Objective: Pulpwood

Objectives of First Cut: To remove overmature, defective, and slow-growing trees. To remove less desirable species so that they will do no more seeding. To make openings and to expose mineral soil to help establish reproduction. To increase spacing to increase growth.

Timber stand improvement measures will be aimed primarily at stimulating the growth of advance reproduction.

Objectives of Second Cut: To improve the growing stock. To increase the growth of advance reproduction. To establish new reproduction wherever needed. Attention will be concentrated upon spacing of residual stock to enhance development of seedlings. And, to remove poor risk as well as large, mature, sound trees. TSI measures similar to those employed at time of first cut.

Second cut to be made 10 years after first cut. Because of contractor problems, the cut took place 11 and 12 years after first cut.

Objectives of Third Cut: To remove all merchantable trees when reproduction has been adequately and firmly established. This cut is made when 85% of the area is covered with a minimum of 1,000 trees per acre 2 feet in height or higher.

The third cut usually will not be made sooner than 20 years nor later than 30 years after the initial cut. If, by the latter time, adequate stocking has not been attained, non-restocking spots will be planted to spruce.

Table 1. -- Volume on compartment and volume cut

Date		Cords per Acre
Dec. 1954	Original stand	20.0
Apr. 1955	Volume removed 1st cut	8.0
Jul. 1956	Residual stand	12.0
Sep. 1966	3rd remeasurement	21.0
Oct. 1966	Volume removed 2nd cut	16.0
Apr. 1967	4th remeasurement	5.0

Table 2. -- Status of reproduction as of June 1965

	Size Class	Number	Percent Spruce-fir
Number	6.0" to 1.0'	4000	54
per	1.0' to 0.49" d.b.h.	3100	42
Acre	2.0' to 0.49" d.b.h.	1000	57
	All classes	7100	49

		Percent stocking	
	Size Class	All Species	Spruce-fir
Percent	Under 1.0'	98	at least 91
Stocking	1.0' to 0.49" d.b.h.	at least 33	at least 22
	2.0' to 0.49" d.b.h.	at least 22	at least 16

COMPARTMENT 33 (NE 1101-23)

STRIP WIDTH-SLASH DISPOSAL CUTTING EXPERIMENT

Anticipating the day when mechanical tree harvesters will be operating in the spruce-fir forests of Maine, this study was established during the winter of 1964-65. We attempted to simulate as much as possible the condition the areas would be in after being cut by either of two types of tree harvesters -- models which leave slash and models which remove the entire above-ground portion of the tree.

Our objective is to measure survival and natural regeneration of tree species as related to three strip widths and three slash disposal treatments for a period of at least five years.

Strip widths are one, two, and three chains with a two-chain seed-source area between clearcut strips. Removal, burning, and leaving in place are the three disposal methods. Treatments were replicated three times. Study area is 54 acres in size. Burning was accomplished during August of the first growing season after timber removal.

An average of 21.5 standard rough cords per acre of all products was removed. One-half of this was spruce-fir and one quarter was hardwoods. The remainder was hemlock and pine (about 10% each) and cedar.

Seedfall is being estimated by using eighty-one 10-inch diameter traps Seedling survival and natural regeneration is being observed on 648 1/4-milacre rectangular plots.

Three year totals indicate that 16 million seeds per acre have fallen on the study area. Of this total 3.8% were spruce; 4.9% were fir; 4.2% other softwoods; and 87.1% were hardwoods.

1-yr old seedlings and older

Shown below is a table indicating the number of seedlings, in thousands per acre before treatment and the percentage reduction or increase two growing seasons after treatment.

Species	Slash Disposal Treatment		
	Remove	Leave in place	Burn
Spruce	1.57 (-43)	1.50 (-29)	2.43 (-99)
Balsam Fir	47.07 (-88)	44.30 (-74)	47.43 (-99.9)
Other Softwoods	5.48 (-46)	3.61 (+41)	3.72 (-100)
Hardwoods	30.65 (+109)	32.43 (+58)	30.81 (+331)
All Species	84.78 (-13)	81.83 (-16)	84.39 (+58)

As a part of this study, the amount of wind damage is being evaluated on over two miles of forest edge. Three year results show a total of 178 downed trees, 3.5 d.b.h. and larger, in the seed-source strips. There is evidence to suggest that perhaps as many as two-thirds of these trees would have been downed even if strip cutting had not taken place. Based on these results, we can conclude that windthrow does not appear to be a serious problem at least during the first three years.

Some characteristics of the 178 downed trees:

a. 90% were balsam fir; 4½% were spruce.

b. 51% fell within 16½ feet of the edge.

c. 55½% fell along the edges of the 3-chain wide strip.

d. Only 8 trees fell into the clearcut strip; 170 within the seed-source area.

e. 46½% were either dominant or codominant.

f. 72% were broken off; 28% were uprooted.

g. Of the broken trees, 67% broke off below d.b.h.

h. 31% fell during the first year; 38% the second year; and 31% the third year.

i. 64½% contained decay in an advanced stage.

j. 33% were classified as being unmerchantable.

(Revised September 1968)

CURRENT RESEARCH STUDIES AT THE ORONO PROJECT

April 1, 1968

NE-1101-2. Spruce budworm experimental cutting plots.
Objective: To determine growth rate, mortality, and volume changes in partially cut spruce-fir stands. (Originally the objective was to test the effectiveness of partial cuttings in reducing losses from spruce budworm attack, but the budworm epidemic did not develop). --Hart.

NE-1101-5. Costs and returns from pruning red spruce.
Objective: To determine the costs of pruning red spruce in natural stands, and compare the increases in net value of pruned and unpruned trees over a period of years. --Frank.

NE-1101-7. Large-scale replicated study of cutting methods and silvicultural systems.
Objective: To determine the cumulative effects of silvicultural techniques upon growing stock and site, and to evaluate the difference between management intensities in terms of costs and returns resulting from them. --Frank.

NE-1101-10. Outplanting of various hybrids and exotic species of white pine and spruce.
Objective: To observe the adaptability of different exotics and hybrids to determine which ones are best suited to the area. --Hart.

NE-1101-12. Growth of pruned red and white spruce in natural stands.
Objective: (1) To study effect of crown length, release, and percent of crown removed on growth of red and white spruce. (2) To compare pruning time of white spruce with red spruce. --Frank.

NE-1101-13. Balsam woolly aphid infestation on Penobscot Experimental Forest.
Objective: To determine the percentage of balsam fir trees infested with balsam woolly aphid, by degree of infestation, on the Penobscot Experimental Forest. --Hart.

NE-1101-15. Cooperative study of wood density of the principal softwood species growing in Maine.
Objective: (1) To determine relation of density at breast height to tree density. (2) To determine relation of density to certain environmental factors. (3) To seek out living trees that are superior in wood density, form, growth rate, and other desirable characteristics.--Hart.

NE-1101-17. Diameter growth response of white spruce trees to various degrees of thinning.
Objective: (1) To determine how soon increased diameter growth occurs after various degrees of thinning. (2) To measure the magnitude of this response. --Hart.

NE-1101-20. Soil-site-growth relationships for the spruce-fir region of Maine.
Objective: To develop growth prediction equations from stand and soil-site factors. --Safford.

NE-1101-23. Establishment and response of spruce (and associated species) to strip clearcutting and slash disposal.
Objective: To determine the effect of 3 strip widths (1-, 2-, and 3-chain) and 3 slash disposal methods (leave, burn, remove) on regeneration of spruce and associated species; and to determine effect of seedbed condition, moisture regime, and ground vegetation on regeneration. --Frank.

NE-1101-25. A comparison of methods for estimating site index of red spruce in uneven-aged stands.
Objective: To evaluate several methods of estimating site productivity. --Safford.

NE-1101-27. Nutrition of paper birch seedlings.
Objective: (1) To compare the growth of paper birch seedlings at various levels of specific nutrients. (2) To determine the nutrient level of optimum growth. --Bjorkbom.

NE-1101-28. Origin and life history of balsam fir thickets.
Objective: To ascertain the effects of six stand variables on the development of balsam fir thickets.--Griffin.

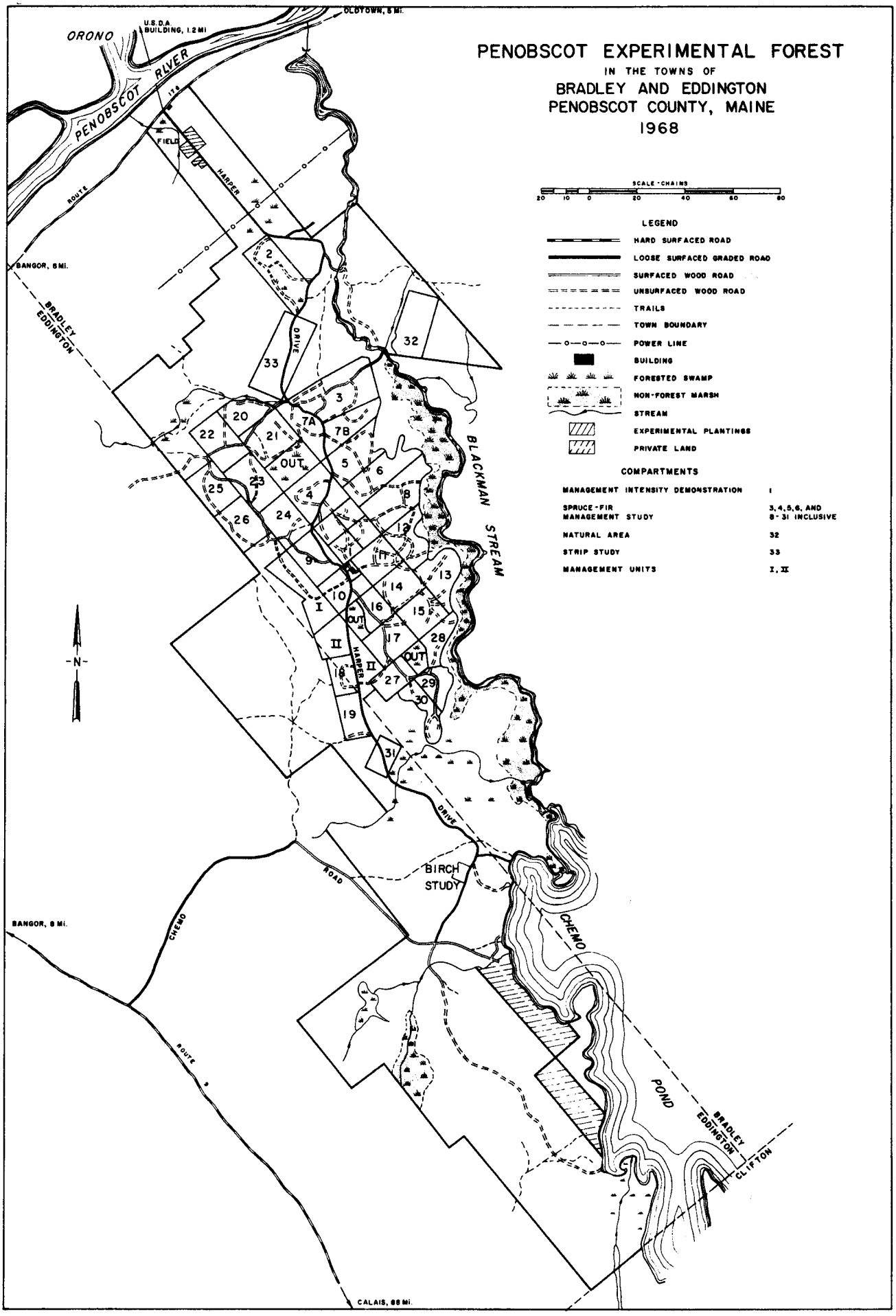
NE-1101-29. Locating sapsucker tree-damage areas.
Objective: To gain experience and secure information about the potentials of a sapsucker calling technique to assist in locating territories occupied by sapsuckers. --Rushmore.

NE-1101-30. Viable seed from coniferous species stored in the forest floor.
Objective: To determine if viable conifer seeds are stored in the forest floor under stands of spruce-fir and associated species. --Frank.

NE-1101-31. Reproduction surviving strip clearcutting by the Beloit Tree-harvester.
Objective: To determine if the percent stocking of surviving seedlings by species groups is reduced below 40 percent. --Frank.

NE-1101-33. Interacting effects of nutrient elements in varying amounts on the growth of paper birch seedlings.
Objective: To investigate the interacting effects of two or more elements, with each element being supplied in various concentrations, on the growth of paper birch seedlings.--Bjorkbom.

NE-1101-34. Influence of soil type and nitrogen fertilization on the foliage nutrient content of red spruce--a preliminary study.
Objective: To determine the variability in foliage nutrient content among red spruce trees on the same soil and among trees growing on different soils; to determine the influence of nitrogen fertilization on the nutrient content of the foliage of trees growing on these same soils. --Safford.


PENOBSCOT EXPERIMENTAL FOREST
IN THE TOWNS OF
BRADLEY AND EDDINGTON
PENOBSCOT COUNTY, MAINE
1968
SCALE - CHAINS
20 10 0 20 40 60 80
LEGEND
HARD SURFACED ROAD
LOOSE SURFACED GRADED ROAD
SURFACED WOOD ROAD
UNSURFACED WOOD ROAD
TRAILS
TOWN BOUNDARY
POWER LINE
BUILDING
FORESTED SWAMP
NON-FOREST MARSH
STREAM
EXPERIMENTAL PLANTINGS
PRIVATE LAND
COMPARTMENTS
MANAGEMENT INTENSITY DEMONSTRATION 1
SPRUCE-FIR MANAGEMENT STUDY 3, 4, 5, 6, AND 8-31 INCLUSIVE
NATURAL AREA 32
STRIP STUDY 33
MANAGEMENT UNITS I, II
ORONO
U.S.D.A. BUILDING, 1.2 MI
OLDTOWN, 5 MI.
PENOBSCOT RIVER
FIELD
HARPER
ROUTE
BANGOR, 6 MI.
BRADLEY
EDDINGTON
DRIVE
BLACKMAN STREAM
OUT
HARPER
BIRCH STUDY
ROAD
CHEMO
POND
CLIFTON
CALAIS, 88 MI.
N